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THE FEEDING HABITS OF FOUR RAPTORS IN CENTRAL ITALY

by
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ABSTRACT. The crop and gizzard contents of 84 Common Kestrels (*Falco tinnunculus*) and 49 Common Buzzards (*Buteo buteo*), as well as the gizzard contents of 113 Little Owls (*Athene noctua*) and 70 Barn Owls (*Tyto alba*) were examined in the district of Siena in Central Italy. Collections were made over three years during the shooting seasons. For all species except the Barn Owl, and in contrast to their diets in European countries further north, insects (instead of birds and small mammals) become the staple food during the colder seasons. This may be due to the high availability of arthropods in the Mediterranean area during autumn and winter.

Introduction

This paper provides quantitative food habit data on two species of diurnal raptors (Common Kestrel and Common Buzzard) and two owls (Little Owl and Barn Owl). All are frequently killed as "pests" in Italy.

Italian shooters, game wardens and farmers kill birds of prey indiscriminately, justifying this practice as "Pest Control." Hundreds of thousands of raptors are eliminated lawfully and unlawfully each year without regard to their ecological role (Lovari 1970, 1973a, 1973b); e.g., Schenk (1972) reports that for Sardinia alone $360,000 (216,000,000 Italian lira) were spent to destroy raptors frum 1957 to 1960. In only the district of Sassari, 959 hawks were killed in 1968.

The mass killing of birds of prey in Italy is all the more unjustified as almost nothing is known of their food habits except for a scant report published by Moltoni in 1937.

Materials and Methods

The district of Siena (3,820 km^2) in Tuscany was chosen as a study area. It includes different types of habitats: hills and plains, cultivated and uncultivated lands, woods and streams. The contents of the crops and gizzards of 84 Common Kestrels and 49 Common Buzzards, and the gizzards of 113 Little Owls and 70 Barn Owls were examined. The birds had been killed during three shooting seasons–1970-71, 1971-72, and 1972-73. Each was delivered to a taxidermist for stuffing, generally on the day of its death. The shooting season in Italy lasts from September to April, thus including both the autumn and spring migrations.

Crop contents studies retrieve more information about prey consumed than

do pellet analyses (Hartley 1948). Delicate insect teguments, for example, can be recovered and identified from crop samples. Moreover, the species of raptor under examination is easily identified, whereas this is not always possible from pellets alone.

The crops were teased apart with pincers. Skulls and parts of skulls of mammals, as well as teguments of arthropods, were saved for identification. Two primary parameters were calculated: (1) total number of individuals of each prey species (or other taxonomic category), and (2) the total number of crops a prey species (or other category) occurred in (i.e., occurrence). Since many crops were empty, percentages of occurrence were calculated using the total number of crops with food, i.e. 65 for Common Kestrels, 26 for Common Buzzards, 79 for Little Owls and 23 for Barn Owls.

Results

Common Kestrel. Thirty-nine crops and gizzards out of the 84 examined were empty. All species preyed upon are listed in Table 1. These are separated

Table 1. Prey of Common Kestrels, September-March.

	Individuals
MAMMALIA	
Rodents	
Pitymys savii	2
Apodemus sylvaticus	2
Mus musculus	1
Clethrionomys glareolus	1
Insectivores	
Sorex minutus	3
Sorex araneus	1
Unidentified	2
AVES	
Carduelis sp.	1
Cisticola sp.	1
Unidentified Passeriformes	3
REPTILIA	
Lacerta (Podargis) muralis	13
INSECTA	
Coleoptera	
Carabidae	9
Tenebrionidae	2
Carabus violaceus	1
Geotrupes sp.	1
Hymenoptera	
Formicidae	27
Orthoptera	
Decticus verrucivorus	40
Decticus sp.	15
Locustidae	9
Decticus albifrons	5
Phasgonura viridissima	5
Oedipoda sp.	1
Acheta campestris	1
Unidentified	16
Others	
Mantis religiosa	6
Libellula sp.	1
OTHER ARTHROPODA	
Arachnida	2
Myriapoda	1
Unidentified	2

by major category and by season in Tables 2a and 2b.

Orthoptera were the main food of the Common Kestrel during autumn (September-November) (Table 2a). Coleoptera and reptiles were also preyed on frequently. The occurrences of both birds and Hymenoptera were low, although a rather large number of Hymenoptera were eaten. Very few birds were taken. Remains of mice and voles were found occasionally, while shrews and vegetable matter seemed to be unimportant.

During the cold season (December-March), Common Kestrels still fed mostly on Orthoptera (Table 2b). The use of rodents, shrews and passerines also increased, whereas plant material and lizards disappeared.

Table 2a. Prey of Common Kestrels, autumn only (September-November 1970-1972).

Prey	Number	%	Occurrence	%
MAMMALIA				
Rodentia	4	2	2	5
Insectivora	2	1	1	3
Unidentified	2	1	2	5
AVES	3	2	3	8
REPTILIA	13	8	5	13
INSECTA				
Coleoptera	17	10	6	15
Hymenoptera	27	16	3	8
Orthoptera	93	55	18	45
VEGETALIA	2	1	1	3
OTHER	6	4	6	15

Table 2b. Prey of Common Kestrels, winter only (December 1970-72 and January-March 1971-73).

Prey	Number	%	Occurrence	%
MAMMALIA				
Rodentia	2	7	2	33
Insectivora	2	7	2	33
AVES	2	7	2	33
INSECTA				
Coleoptera	1	3	1	16
Orthoptera	21	72	2	33
OTHER	1	3	1	16

Common Buzzard. Twenty-three crops and gizzards of the 49 birds examined were empty. The species preyed upon from September to March are listed in Table 3. These data are detailed with regard to season in Tables 4a and 4b.

Orthoptera appeared to be the main prey during the autumn (Table 4a). A remarkable number of lizards and snakes were also preyed upon. Coleoptera, insectivores and rodents did not constitute an important part of the Common Buzzard's diet. Vegetable matter was found in three crops, whereas–unexpectedly–no bird remains were recovered.

Table 3. Prey of Common Buzzards, September-March.

MAMMALIA	**Individuals**
Rodents	
Pitymys savii	5
Apodemus sylvaticus	1
Clethrionomys glareolus	1
Insectivores	
Crocidura suaveolens	3
Crocidura russula	1
Talpa europaea	1
Carnivores	
Mustela nivalis	1
Unidentified	2
AVES	
Unidentified Passeriformes	1
REPTILIA	
Lacerta (Podargis) muralis	10
Natrix natrix	6
ANURA	
Rana esculenta	3
Unidentified	1

INSECTA	**Individuals**
Coleoptera	
Scarabaeidae	3
Carabus violaceus	1
Procrustes coriaceus	1
Ocypus olens	1
Geotrupes sp.	1
larva (*Cebrio* sp.)	1
Orthoptera	
Decticus verrucivorus	22
Decticus albifrons	14
Decticus sp.	2
Phasgonura viridissima	1
Locustidae	1
Others	
larvae (Lepidoptera)	4
Mantis religiosa	1

During winter, Common Buzzards seemed to feed mostly on rodents and still on Orthoptera (Table 4b). Lizards, snakes and frogs were also preyed upon frequently. Shrews, moles, beetles, passerines and vegetable matter were used only rarely.

Table 4a. Prey of Common Buzzards, autumn only (September-November 1970-72).

Prey	Number	%	Occurrence	%
MAMMALIA				
Rodentia	1	2	1	7
Insectivora	2	3	2	14
REPTILIA	12	18	4	29
INSECTA				
Coleoptera	5	8	2	14
Orthoptera	37	56	8	57
VEGETALIA	3	5	3	21
OTHER	6	9	3	21

Table 4b. Prey of Common Buzzards, winter only (December 1970-72 and January-March 1971-73).

Prey	Number	%	Occurrence	%
MAMMALIA				
Rodentia	6	21	6	50
Insectivora	3	10	2	17
Unidentified	2	7	2	17
AVES	1	3	1	8
REPTILIA	4	14	2	17
ANURA	4	14	2	17
INSECTA				
Coleoptera	2	7	2	17
Orthoptera	5	17	2	17
VEGETALIA	1	3	1	8
OTHER	1	3	1	8

Little Owl. Thirty-four gizzards out of the 113 examined were empty. The species preyed upon from September to March are listed in Table 5. These are separated by season in Tables 6a and 6b.

During autumn, insects made up 95% of the total number of prey (Table 6a). Most exploited were earwigs, Hymenoptera and Coleoptera. Little Owls also fed upon small mammals and vegetable matter, but preyed on passerine birds, liz-

Table 5. Prey of Little Owls, September-March.

	Individuals
MAMMALIA	
Rodents	
Pitymys savii	3
Apodemus sylvaticus	2
Insectivores	
Crocidura leucodon	1
Suncus etruscus	1
Sorex sp.	1
Unidentified	7
AVES	
Unidentified Passeriformes	1
REPTILIA	
Lacerta (Podargis) muralis	1
ANURA	
Hyla arborea	1
INSECTA	
Coleoptera	
Carabidae	65
Pentodon punctatus	13
Geotrupes stercorarius	2
Ocypus olens	8
Geotrupes sp.	5
Tenebrionidae	5
Procrustes coriaceus	4
Sphodrus sp.	4
Curculionidae	3
Carabus cancellatus	2
Saperda carcharias	1
Bubas sp.	1
Carabus violaceus	1
larva (Carabidae)	1
larva (Staphylinidae)	1
Helops sp.	1
Unidentified	36
Dermaptera	
Forficula auricularia	356
Hymenoptera	
Formicidae	141
Vespa crabro	1
Orthoptera	
Decticus verrucivorus	8
Decticus albifrons	5
Phasgonura viridissima	2
Locustidae	2
Oedipodae	2
Ephippigerida sp.	1
Unidentified	8
Others	
larvae (Lepidoptera)	7
OTHER ARTHROPODA	
Arachnida	3
Julus sp.	3
Glomeris sp.	1
Scolopendra sp.	1
Unidentified	3
MOLLUSCA	
Helix sp.	1

ards and frogs only occasionally.

During the cold season, there was an increase of small mammals, although earwigs still remained the staple food (Table 6b). Coleoptera were also used frequently, and a small amount of vegetable matter was consumed.

Table 6a. Prey of Little Owls, autumn only (September-November 1970-72).

Prey	Number	%	Occurrence	%
MAMMALIA				
Rodentia	2	0.4	2	4
Insectivora	1	0.2	1	2
Unidentified	2	0.4	2	4
AVES	1	0.2	1	2
REPTILIA	1	0.2	1	2
ANURA	1	0.2	1	2
INSECTA				
Coleoptera	121	25	24	47
Dermaptera	179	36	22	43
Hymenoptera	142	29	4	8
Orthoptera	25	5	13	26
VEGETALIA	6	1	4	8
OTHER	12	2	8	16

Table 6b. Prey of Little Owls, winter only (December 1970-72, January-March 1971-73).

Prey	Number	%	Occurrence	%
MAMMALIA				
Rodentia	3	1	3	7
Insectivora	2	1	2	5
Unidentified	5	2	5	11
INSECTA				
Coleoptera	42	17	12	27
Dermaptera	177	73	14	32
Orthoptera	2	1	2	5
VEGETALIA	2	1	2	5
OTHER	9	4	4	9

Barn Owl. Forty-seven gizzards out of the 70 examined were empty. The species preyed upon from September to March are listed in Table 7, while Tables 8a and 8b give these data by season.

The analysis of full crops showed a high percentage of rodents and shrews in the autumn diet (Table 8a). Two Barn Owls also preyed upon a large number of Orthoptera.

During the cold season, only rodents and shrews were recovered (Table 8b).

Table 7. Prey of Barn Owls, September-March.

	Individuals		Individuals
MAMMALIA		*Sorex araneus*	2
Rodents		*Sorex minutus*	1
Apodemus sylvaticus	14	*Suncus etruscus*	1
Pitymys savii	2	Unidentified	2
Mus musculus	5	INSECTA	
Muscardinus avellanarius	2	Orthoptera	
Insectivores		*Decticus albifrons*	2
Crocidura suaveolens	4	Unidentified	16
Crocidura russula	2		

Table 8a. Prey of Barn Owls, autumn only (September-November 1970-72).

Prey	Number	%	Occurrence	%
MAMMALIA				
Rodentia	22	45	11	79
Insectivora	7	14	6	43
Unidentified	2	4	2	14
INSECTA				
Orthoptera	18	37	2	14

Table 8b. Prey of Barn Owls, winter only (December 1970-72 and January-March 1971-73).

Prey	Number	%	Occurrence	%
MAMMALIA				
Rodentia	10	77	8	89
Insectivora	3	23	3	33

Discussion

Common Kestrel. This falcon normally hunts in flight, hovering from time to time and swooping down when a prey is in sight. Kestrels usually seize their pery on the ground and only exceptionally in flight (Uttendörfer 1952). They may also remain for long periods on a branch from which they then strike their prey (Cavé 1968).

Long-tailed Field Mice (*Apodemus sylvaticus*) constituted 80% of food items taken by Common Kestrels in Germany (Uttendörfer 1952), whereas Cavé (1968) found that the Common Vole (*Microtus arvalis*) was the main source of food in the Netherlands, except when voles were scarce: then insects and birds—mostly young Starlings (*Sturnus vulgaris*)—were preyed upon.

Ellis (1946) reported that Field Voles (*Microtus agrestis*) were the main prey in England during autumn with a change to birds with the onset of cold weather. A definite rise in beetle consumption (mostly *Geotrupes* sp.) occurred in September and October. According to Davis (1960) many late winter pellets contained much earth and, sometimes, vegetable material.

In France, Thiollay (1963) wrote that the main prey items found in pellets during autumn were rodents (87% of the total number of prey), insects (9.3%) and birds (2.1%). He also found that the exploitation of insects increased during winter (15%). Rodents, however, still constituted the major part of the diet (73%). Birds (0.5%) and reptiles (0.3%) were also preyed upon, though inconsistently.

From the data listed by Moltoni (1937) arthropods and mice seem to be the commonest prey in Italy. On the basis of my results, however, insects (mostly crickets and grasshoppers) constitute the staple food of Common Kestrels during autumn and winter. This is not in agreement with the findings reported in Germany, the Netherlands, Great Britain and France, nor wholly with those of Moltoni in Italy.

Italian Common Kestrels may have developed a food preference for insects, possibly due to the Mediterranean climate (winter rains); insects are available throughout the year, though they are not so numerous in winter (Blondel 1969). Individual food preferences have been reported by Slijper (1960) for captive Common Kestrels. This tendency, together with climatic peculiarities, may facilitate the onset of a local feeding behavior.

Common Buzzard. Buzzards are active from sunrise to sunset, and their usual hunting techniques very much resemble those of the Common Kestrel (Géroudet 1965). Pinowski and Ryszkowski (1962) have shown that Common Buzzards may adapt their hunting methods to available prey.

In Germany Wendland (1952) and Mebs (1964) have found that Common Buzzards feed mostly on voles, particularly on Common Voles, and also on *Arvicola* sp. and moles (*Talpa europaea*). The most commonly preyed upon birds are Jays (*Garrulus glandarius*). Great Spotted Woodpeckers (*Dendrocopos major*), Starlings and Mistle Thrushes (*Turdus viscivorus*).

Glutz *et al.* (1971) have reviewed the available data for Central Europe. From

their report one can infer that about 70% of vertebrates caught are small mammals—particularly voles—15% are birds, 10% are reptiles and 4% amphibians.

In Poland Czarnecki and Foksowicz (1954) have found that 50% of the prey items brought to nestling Common Buzzards are moles; 33% are Common Voles. The authors attribute such a high predation upon moles to particular environmental conditions. It is possible that Common Buzzards, by observing the movements of the soil, are able to locate moles in the process of digging. Pinowski and Ryszkowski (1962) have shown that Common Voles and moles are the most frequent prey in spring, whereas during winter the diet is more varied. However Common Voles and Root Voles (*Microtus ratticeps*) still constitute 40% of the prey.

Data reported by Thiollay (1968) in France show that small mammals—mostly rodents—make up 47% of the diet, birds 43%, reptiles and insects 10%.

The winter diet of the Italian Common Buzzards I examined resembles that of those studied in Germany, Poland and France. The autumn diet, on the contrary, appears strikingly different: birds are entirely lacking, and there is unexpectedly little predation upon rodents. Rodents are the staple food of Common Buzzards in the above mentioned countries but seem here to be replaced by insects.

Little Owl. The hunting habits of the Little Owl distinguish it from the other Strigiformes. It is usually very active at sunset and at night, but it is the only European owl seen to hunt during the day as well, especially during the nesting season (Hibbert-Ware 1938). It is also the only owl which eats plant food, at least during winter (Thiollay 1968).

Few studies have been published on its diet, except for a thorough inquiry carried out in Great Britain on the ecological niche occupied by this owl (Hibbert-Ware 1938). The results show that its staple diet throughout the year consists of insects and rodents. Birds are an important food only during the nesting season: the birds most commonly taken are Starlings, House Sparrows (*Passer domesticus*), Blackbirds (*Turdus merula*), and Song Thrushes (*T. philomelos*). According to a report of the Eley Game Advisory Station (1967) in England, the Little Owl preys upon an unimportant number of young gamebirds.

In France Thiollay (1968) found that rodents (17.2% of the total number of prey), shrews (2%) and, above all, insects (80.8%) constitute the diet in March. The same groups of animals are also preyed upon in July, though with slightly different percentages: respectively, 8.4%, 6.7% and 83.5%. Molluscs (*Helix* sp.) are also exploited, making up the remaining 1.5%.

From the report of Moltoni (1937) in Italy one could conclude that insects make up the main part of the diet. My results indicate that the Little Owl feeds mainly upon insects during autumn and winter, with a preference for earwigs, although beetles are frequently eaten, too. Small mammals, birds, reptiles and amphibians are consumed in small quantities.

Barn Owl. Barn Owls hunt during the night, locating their prey by hearing (Payne 1962, 1971).

In Germany Uttendörfer (1952) has reported that Barn Owls feed chiefly on small mammals. Thiollay (1968) has shown that 90% of the prey in France are small mammals, mainly *Microtus* and *Apodemus* sp. Amphibians make up 3.75% whereas birds and insects are very rare. He also points out that the proportion of the prey items during the year is remarkably constant for this owl. Previous data from Italy suggest that rodents are the primary food, followed by insects, shrews and birds (Montoni 1937).

Feeding habits of the Barn Owl have been studied extensively in the United States (e.g., Marti 1969; Greer and Gilstrap 1970; Reese 1972), as well as in Canada (Doerksen 1969), Malaysia (Medway and Yong 1970) and Iraq (Nader 1969). Rodents—mostly voles—make up 75-98% of the total number of prey animals. Birds and insects are preyed upon only in unimportant numbers. In Africa Laurie (1971) has reported that shrews are the commonest prey.

My results also seem to indicate that Barn Owls are specialized in feeding upon small mammals, chiefly *Apodemus* and *Pitymys* sp. in the area of my study.

Conclusions

My data are congruent with reports of the other European authors as far as the Barn Owl is concerned. For the Little Owl the differences are quantitative: the same types of prey are taken in England, France and Italy, but in different amounts. Insects predominate in autumn and winter in my study. For the Common Kestrel, the seasonal differences are even more striking, as insects constitute the staple food in both autumn and winter, whereas in other countries rodents are the staple. For the Common Buzzard, the differences are equally striking, though only in autumn: again rodents as the staple food are replaced by insects, while birds are entirely lacking.

The fact that three out of the four species studied prey so heavily upon insects during autumn and winter may be due to the abundance of arthropods at that time in the Mediterranean area, in contrast to their scarcity further north. Another reason may be the relative rarity of birds caused by the heavy Italian hunting pressure.

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A NEW TYPE OF RAPTOR TRAP

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A new device for trapping raptors has been developed. It consists of a multi-branched stick with nylon monofilament nooses attached and a lure animal, such as a mouse, tethered beneath. The trap uses the same principle as the bal-chatri, i.e., entangling the raptor's toes or feet in the nooses supported above a lure animal. The trap is unique, however, in that the branched stick is so "un-trap-like" (Fig. 1); it should enable researchers to capture wary raptors where conventional traps might fail. I have used this trap successfully on Red-tailed Hawks (*Buteo jamaicensis*) and, in one instance, trapped an individual that the standard wire cage bal-chatri had failed to trap.

Although the trap is mobile and can be delivered in the same fashion as a bal-chatri, it does have certain drawbacks. The most obvious disadvantage is that the lure animal is exposed and vulnerable. Particular care is also required to drop the trap in the field from a moving vehicle so as to have the trap land upright.

Some important considerations in assembling the trap include:

(1) The stick used must be flexible, yet tough. Shrubbery, such as Barberry (*Berberis* sp.) or Greenbriar (*Smilax* sp.), are recommended.

(2) The mouse, tethered beneath the prongs of the stick, will foul the loops unless the prongs are bowed upward.

(3) A drag weight, preferably camouflaged, *must* be attached to the stick trap.

(4) The size of the branch used must guarantee that the raptor trapped cannot break it.

This is a preliminary report, and I would appreciate knowing what results are obtained by anyone who attempts to use this type of trap. I would also like to extend my appreciation to Mr. G. Robert Ganis for his assistance in the initial field of trials of this trap and for the photograph included.

Manuscript received August 10, 1974.

Figure 1. A new type of raptor trap.

COMPARISON OF SHELL THICKNESS IN WILD AND CAPTIVE PRAIRIE FALCONS

by
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A study of variations in shell thicknesses among eggs of captive and wild Priaire Falcons (*Falco mexicanus*) was undertaken in order to quantify the relationship between embryo viability and shell thickness and also to determine the extent to which artificial environments may be affecting these two parameters. Shell thickness was considered to be a reliable indicator of eggshell quality inasmuch as shell thickness is directly related to the eggshell's ability to: (1) protect the embryo from external pressures; (2) regulate the rate of exchange of H_2O, O_2, and CO_2; and (3) provide a barrier to invading bacterial and mycotic microorganisms (Romanoff and Romanoff 1949, Simkiss 1967).

A total of 43 eggshells was obtained from seven healthy falcons in the captive breeding projects at the University of Missouri and Cornell University, and another 27 eggshells were collected from 27 eyries in Colorado, Wyoming, and Nebraska. Except for the two eggs identified as P-L-11 and P-SB-12, all eggshells from wild falcons were analyzed for DDE residues and found to contain less than 2 ppm (wet basis) of this compound; thus DDE-induced shell thinning would be undetectable. The "wild" shells should therefore be fairly representative of a normal healthy population of wild Prairie Falcons.

Sections measured were taken from the equatorial region of each shell since this region is characteristically the most uniform portion of the shell (Tyler and Geake 1961). Shells were soaked in water to loosen the allantoic membrane and the membrane was then mechanically removed from the sections so that shell thickness could be accurately measured. Each equatorial shell section was subsequently measured at five sites with an Ames (Waltham, Massachusetts) eggshell micrometer. The mean shell thickness (x) and the corresponding standard deviation (σ) for each egg are presented in Tables 1 and 2.

Eggs were grouped according to the history of the respective falcon (i.e. wild or captive) and were further subgrouped according to the embryonic history of the egg. Eggs which were either infertile or which suffered embryonic mortality within the first two weeks of incubation were considered together inasmuch as embryonic utilization of shell calcium does not take place during the early phases of incubation (Johnston and Comar 1955). Thus shell thickness for the eggs in this group should not have been affected by the presence or absence of a developing embryo.

The second major subgrouping includes all those eggs in which the embryo went full term. Shells in this group should have undergone some thinning inasmuch as the shell is the primary source of calcium for the embryonic skeletal system (Romanoff 1972).

The remaining eggs, i.e. those in which the embryo survived more than two weeks but did not go the full term, represent the third subgroup. These eggs should exhibit some degree of embryo-induced shell thinning, but the extent to which this is so is not known. Therefore, the seven eggs in this subgroup were not considered in the ensuing analysis and are presented only for completeness.

Figurds 1 and 2 represent 41 eggs which were laid by seven captive falcons. In Figure 1 is seen the distribution in shell thicknesses ($x = 274.6\mu$) of 21 hatched eggs from four captive falcons. Figure 2 depicts the corresponding distribution in shell thicknesses ($x = 277.9\mu$) for 20 eggs which were either infertile or

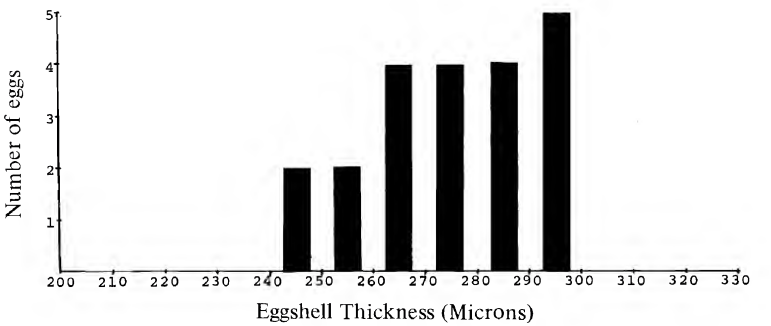

Figure 1. Eggs in which embryo went full term (captive falcons).

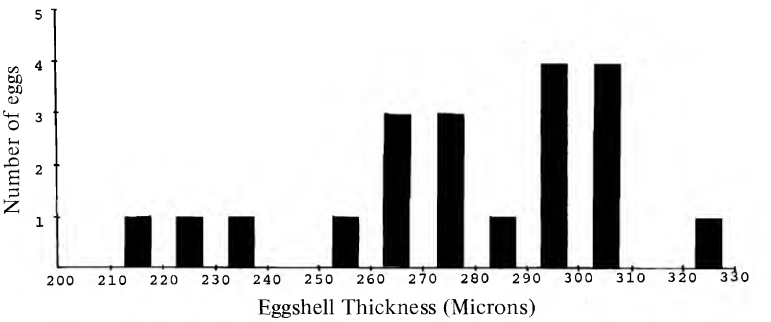

Figure 2. Eggs in which embryo lived less than two weeks (captive falcons).

in which embryo mortality occurred within the first two weeks of incubation. These 20 eggs were collected from five captive falcons.

Figures 3 and 4 are based on 22 eggs from 22 different wild falcon nest sites. The mean shell thickness for the 10 hatched eggs from 10 wild falcons is $x = 299.1\mu$, whereas the mean thickness for the 12 infertile or "early embryonic death" eggs is $x = 256.6\mu$.

A summation of the captive- and wild-hatched eggs is seen in Figure 5. Thirty-one eggs from 14 falcons are represented. Mean shell thickness for all hatched eggs is $x = 282.5\mu$. Figure 6 is a similar grouping of the eggs presented in Figures 2 and 4. The mean shell thickness for these 32 eggs from 17 captive and wild falcons is $x = 269.9\mu$.

An analysis of variance indicates no significant difference in shell thicknesses for the two captive populations (i.e. hatched vs. infertile or early embryonic

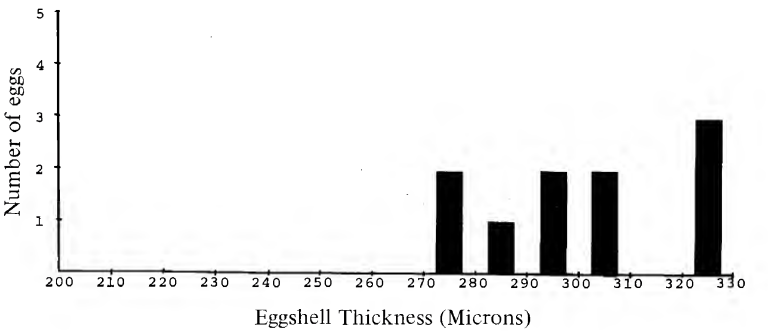

Figure 3. Eggs in which embryo went full term (wild falcons).

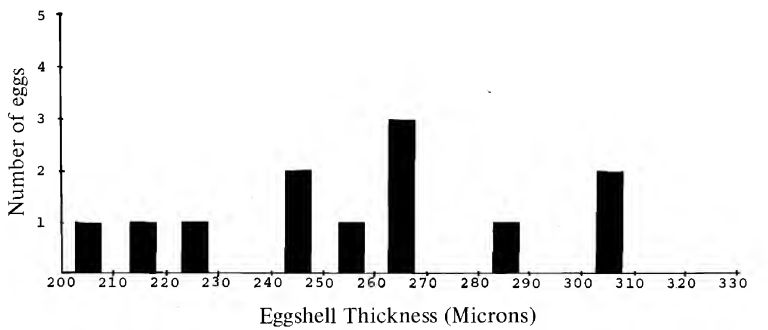

Figure 4. Eggs in which embryo lived less than two weeks (wild falcons).

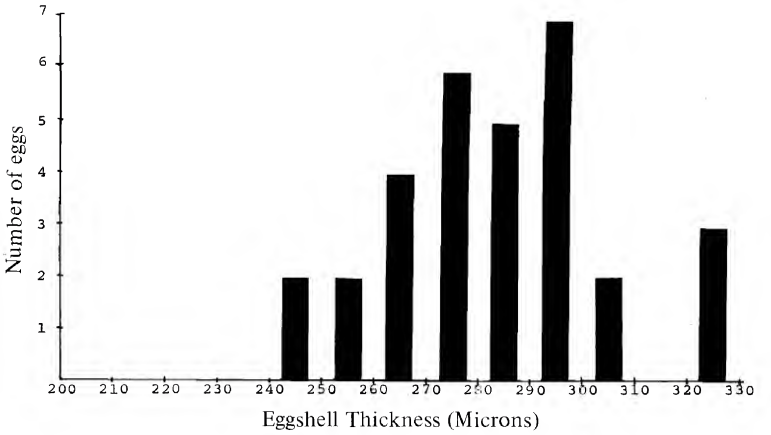

Figure 5. Eggs in which embryo went full term (captive and wild falcons).

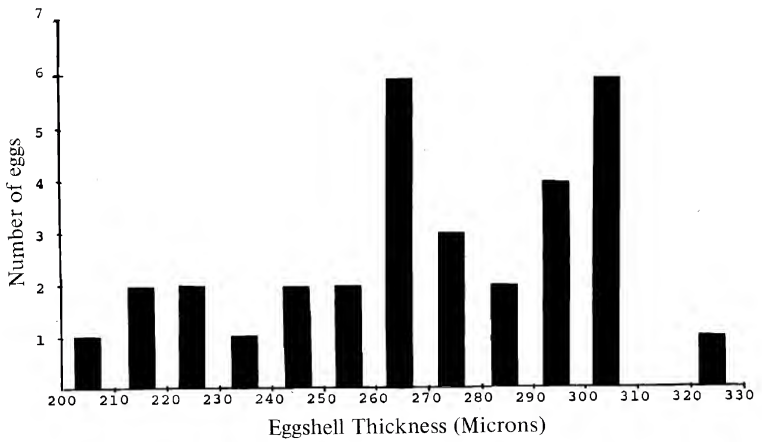

Figure 6. Eggs in which embryo lived less than two weeks (captive and wild falcons.

Table 1. Eggs laid by captive Prairie Falcons.

Egg ID No.	x(μ)*	σ(μ)**	History
D-5-73	248	5.1	eyas died at pip
P-2-7-74	248	2.5	eyas fledged
D-6-73	250	27.6	eyas fledged
P-1-3-74	255	5.5	eyas died from Pseudomonas infection
D-3-73	260	16.6	eyas killed by parents
P-2-9-74	266	3.7	eyas fledged
P-2-8-74	267	5.1	eyas fledged
P-2-6-74	268	5.1	eyas fledged
D-1-3-74	270	7.1	eyas died at pip
W-S-1-5	272	5.1	eyas fledged
D-1-73	277	5.5	eyas died
D-1-1-74	278	4.9	eyas died from Pseudomonas infection
P-1-5-74	283	5.1	eyas died from Pseudomonas infection
D-2-6-74	284	10.1	eyas died at pip
P-1-1-74	287	4.0	eyas died from Pseudomonas infection
W-S-1-3	287	4.0	eyas fledged
P-1-4-74	290	11.4	eyas died from Pseudomonas infection
W-LC-PF-1	292	5.1	eyas fledged
W-S-1-2	294	8.6	eyas died at pip
W-S-2-4	295	5.9	eyas fledged
P-1-2-74	295	7.7	eyas died from Pseudomonas infection
D-2-5-74	262	6.8	embryo died during 4th week
D-2-2-74	271	3.7	embryo died during 3rd week
W-SH-1-2	219	17.4	infertile
W-CPF-1-4B	223	14.4	infertile
W-SH-1-1	239	11.6	infertile
D-9-72	255	5.5	infertile
D-10-72	262	14.4	infertile
D-8-72	263	10.3	infertile
D-2-73	265	12.3	embryo died during 1st week
W-CPF-1-2	271	6.6	infertile
W-SG-1-1	273	4.0	infertile
W-CPF-2	274	5.8	infertile
D-2-3-74	286	5.8	embryo died during 2nd week
D-2-1-74	290	8.3	infertile
W-SG-1-2	291	10.0	infertile
W-CPF-1-1	295	6.3	infertile
W-SG-1-3	295	12.2	infertile
W-CPF-1-3B	305	13.8	infertile
D-7-72	307	14.4	infertile
W-S-1-1	308	13.6	embryo died during 2nd week

Table 1. (continued)

Egg ID No.	x(μ)*	$\sigma(\mu)$**	History
D-4-73	308	21.2	infertile
W-S-1-4	329	9.7	embryo died during 2nd week

*x(μ) = mean shell thickness (5 sites) at equator.
**$\sigma(\mu)$ = standard deviation.

Table 2. Eggs laid by wild Prairie Falcons.

Egg ID No.	x(μ)*	$\sigma(\mu)$**	History
E-GW-1	276	13.9	eyas hatched
E-AR	278	13.2	eyas hatched
E-CN	281	12.1	eyas hatched
E-LT	294	10.5	eyas hatched
E-C	295	18.2	eyas hatched
E-SC	300	10.6	eyas hatched
E-L	302	18.3	eyas hatched
E-SSC	320	9.2	eyas hatched
E-NL	320	9.9	eyas hatched
E-OR	325	7.8	eyas hatched
E-T	213	2.4	embryo died during 4th week
E-TN	227	8.1	embryo died during 4th week
E-WR	229	12.6	embryo died during 4th week
E-GW-2	237	5.1	embryo died during 3rd week
E-F	270	7.8	embryo died during 4th week
P-L-11	209	8.0	infertile
P-SB-12	211	6.6	infertile
E-PF-8	223	9.2	infertile
E-PF-6	240	5.5	infertile
E-PF-1	249	3.7	infertile
E-PF-11	254	3.7	infertile
E-PF-12	264	8.0	infertile
E-PF-10	269	3.7	infertile
E-PF-3	269	6.6	infertile
E-PF-2	281	5.8	infertile
E-PF-5	305	6.3	infertile
E-PF-4	305	8.9	infertile

*x(μ) = mean shell thickness (5 sites) at equator.
**$\sigma(\mu)$ = standard deviation.

death) but does indicate a significant difference ($P < .01$) in the shell thicknesses for the two analogous wild populations. The unsuccessful eggs in the wild and captive populations exhibit similar shell thickness distributions, whereas the wild-hatched eggs have significantly thicker ($P < .01$) shells than do the captive-hatched eggs. Considering the fact that all captive eggs were placed in an artificial incubator, whereas the wild eggs were incubated by the respective falcons, it is not surprising to find that the wild egg requires a thicker, stronger shell to withstand successfully the trauma of natural incubation. In conclusion, we have found no manifestation of thinning due to nutritional deficiency in the shells of captive Prairie Falcon eggs.

Acknowledgments

The following persons contributed eggshells to this investigation: James Enderson, Colorado College, Colorado Springs, Colorado; J. R. Peters, University of Missouri, Columbia, Missouri; James Weaver, Cornell University, Ithaca, New York; and R. Dembenski, Columbia, Missouri.

D. P. Hutcheson, Sinclair Research Farm, University of Missouri, assisted in the statistical analysis.

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ACTIVITY PERIODS, HUNTING METHODS, AND EFFICIENCY OF THE FERRUGINOUS HAWK

by
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ABSTRACT. This paper presents some preliminary results from an ongoing study of the feeding behavior of the Ferruginous Hawk in northern Curlew Valley, Idaho. Information on activity periods, hunting methods, and success rates was obtained by direct observation of a single pair of hawks during the nestling stage. The male did all of the hunting, foraging actively throughout the day but with definite peaks in the morning and evening. About 15% of his strikes were successful; success rate depended on the method of hunting used.

The mobility of birds of prey has often prevented investigation of their activity patterns and feeding behavior. Studies of food habits by pellet analysis comprise the bulk of the raptor feeding literature. This paper presents new information on the feeding behavior of the Ferruginous Hawk (*Buteo regalis*) in southern Idaho. The study was supported, in part, by a grant from the Society of the Sigma Xi.

Study Area and Methods

From 19 May to 15 June 1974, I spent nearly 200 hours in a blind overlooking the nest and range of a single pair of Ferruginous Hawks. This observation period began when the birds' three nestlings were approximately one week of age and ended about a week before they fledged.

Using a pair of 8 x 30 binoculars and a 20x spotting scope, I watched the adult male whenever he left the vicinity of the nest and recorded his activities until he returned or was lost to view. Despite previous reports that the adult hawks often forage together (Cameron 1914, Angell 1969), all hunting by this pair was performed by the male.

The study area was in northern Curlew Valley, Idaho, approximately 10 km north of Snowville, Utah. The hawks' nesting range encompassed slightly more than 21 km^2 of patchy habitat. The nest itself was located in a solitary Utah juniper (*Juniperus osteosperma*) tree at the edge of the denser juniper forest which covered the southern foothills of the Sublett Range. Most of the hawks' range consisted of agricultural land used for growing alfalfa and grain or as pasture for sheep, horses, and cattle. Much of the land near the foothills supported a sage-grass (*Artemisia tridentata-Agropyron cristatum*) community which was grazed by cattle. The topography of the range was essentially flat but sloped

gently from the foothills in the west to Deep Creek in the east.

Results and Discussion

Activity Periods. Few authors have commented on the activity periods of nesting Ferruginous Hawks. The only attempt at a quantitative analysis was that of Smith and Murphy (1973), which was apparently based on very little data. They indicated that the hawks hunted actively only for three hours in the morning (0600 to 0900) and three hours in the evening (1800 to 2100). They recorded essentially no activity during the remainder of the day.

My observations on the activities of the male hawk are presented in Figure 1. Figure 1a gives the distribution of time spent away from the nest area. Most of this time was spent actively hunting, although some of the mid-day soaring flights may have represented exploratory behavior. Figure 1b indicates the average number of observed strikes per hour of observation time. It is apparent that the bird foraged actively throughout the day, but with definite peaks in the morning and evening. The very low number of strikes during the mid-day period was due both to reduced hunting activity and to the difficulty I had in observing the hawk at this time. Heat wave distortion at mid-day greatly reduced my visual range, and it occurred at a time when the hawk tended to range more widely, often in high altitude flight. During this period the bird was frequently lost to view. Consequently, I witnessed a smaller proportion of his strike attempts at mid-day than in the morning or evening, when viewing conditions were greatly improved. Figure 1c presents the hourly rate at which the male brought prey items to the nest. This curve parallels Figure 1b except during the mid-day period, for the reasons given above.

The size of each prey item may have a bearing on the duration of the hawk's activity periods. On my study area, the largest available prey were Townsend's ground squirrels (*Spermophilus townsendii*) and northern pocket gophers (*Thomomys talpoides*). Other studies have indicated that jackrabbits (*Lepus* sp.) are the major prey (by biomass) of Ferruginous Hawks in areas less disturbed by man (e.g. Smith and Murphy 1973). The smaller average size of available prey in my study area may have forced the male to spend more time foraging in order to meet his own food requirements, as well as those of his mate and young. The fact that the female did not hunt may also have placed a greater burden on the male and increased his hours of activity.

Hunting Methods. I observed a total of 430 attempts at prey capture by the male. These have been grouped, in this analysis, according to the bird's hunting method. Hunting methods are distinguished by the position of the hawk at the initiation of the strike. Despite some variability within each strike type, this criterion allowed the division of total strikes into four easily recognizable techniques. These are: hunting from a perch, from the ground, from low altitude, and from high altitude (soaring) flight.

(1) *Hunting from a perch.* The male used wooden fence posts exclusively as hunting perches. Other potential perches (telephone poles, abandoned buildings

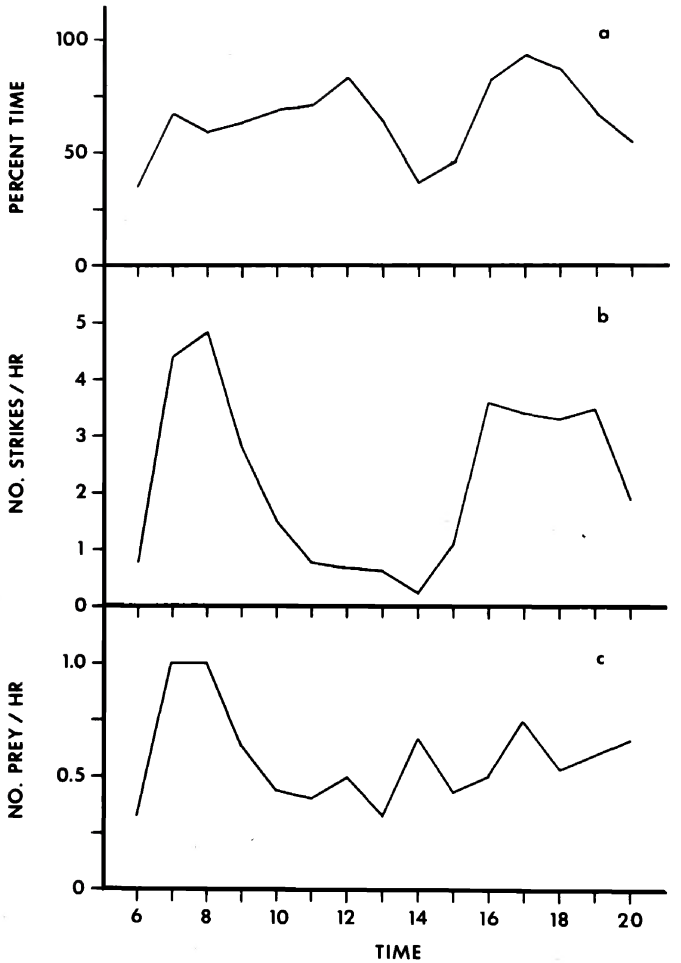

Figure 1. Three indicators of the male's activity periods: (a) percent of time spent away from the immediate vicinity of the nest, (b) time distribution for all observed strikes, (c) time distribution for all prey returned to the nest. Abscissa gives time at start of hourly interval (6 = 0600, 12 = 1200, etc.).

and farm machinery, and scattered trees and shrubs) were largely ignored. On one occasion, I observed the hawk perched on a telephone pole but no strikes were attempted, and the bird left after a few minutes. The male frequently perched on the scattered juniper trees near the nest but was never observed hunting there, despite the presence of prey as revealed by trapping.

When attempting to capture a detected prey item, the hawk would leave his perch with one or more shallow wing beats, glide for a distance at altitudes often less than 1 m, and strike with the feet, usually raising a cloud of dust on impact. The distance between perch and prey varied from less than 10 m to more than 100 m. If the strike was unsuccessful, the bird often flew directly to another perch after the brief impact. Successful strikes were marked by an abrupt stop, occasionally sending the bird sprawling in the dirt.

(2) *Hunting from the Ground.* Strikes from a perch and from the ground were frequently interspersed in a single hunting effort. The bird probably hunted from the ground only in places where he had previously detected a rodent at the entrance to its burrow. The limited strike distance (usually about 1 m) may have made this technique unsuitable in an area of unknown prey activity.

On the ground, the hawk either sat with his belly in contact with the dirt, or stood, usually with his body in a near horizontal posture. The bird seldom moved; all attention seemed to be focused on the entrance to a particular burrow. The strike itself was an instantaneous lunge at the prey, always using the feet.

(3) *Hunting from Low Flight.* At the beginning of the study, I arbitrarily defined low altitude as less than about 30 m. It soon became apparent that this was a useful distinction, and one which was easily made in the field. Relatively few flights occurred at this borderline altitude except when the bird changed from high to low flight, or vice versa. Most high altitude flights were well above 100 m. Most low altitude flights were below 20 m.

Upon detection of prey, the hawk in low flight would descend at an angle which varied according to the bird's distance from the prey item. Prey animals directly beneath the bird elicited a near vertical dive and an apparent hard impact. Usually, however, the descent was at less than 45 degrees, and a short, low-level glide often preceded the actual impact. As with strikes from a perch, after unsuccessful capture attempts the hawk usually continued his flight without landing. A successful capture brought the bird to an immediate halt.

(4) *Hunting from High Flight.* High altitude flights were those greater than 30 m; however, most were greater than 100 m. High altitude strikes differed from the others in the greater time between detection and attempted capture of the prey item. Strikes from a perch, the ground, or low flight, appeared to be almost instantaneous responses to the stimulus of a vulnerable prey. At high altitudes, however, the bird may have to choose whether or not to strike based on the amount of time the prey animal is exposed.

Most high altitude strikes were initiated from stationary, hovering flight. Hovering was frequent but only seldom resulted in a strike. The vertical descent was usually slow, the hawk floating on partially folded wings. The bird would often

hover briefly at intermediate levels in his descent, perhaps reacting to movements of his prey. The final phase of the descent was usually near vertical, but occasionally the hawk glided a few meters at low level before impact.

Predatory Efficiency. Predatory efficiency is the ratio of successful strikes to total attempted strikes. For the majority of raptors this ratio is unknown. Lambert (1943) and Ueoka and Koplin (1973) calculated an over-all efficiency of 89 and 82 percent, respectively, for the American Osprey (*Pandion haliaetus*). Similarly, Collopy (1973) recorded a 51 percent success rate for American Kestrels (*Falco sparverius*) in northern California. An average efficiency of 7.6 percent was determined by Rudebeck (1951) for four European raptors (*Accipiter nisus, Falco columbarius, F. peregrinus,* and *Haliaeetus albicilla*). My observations are apparently the first for a *Buteo.*

Table 1 summarizes the outcome of all observed strikes by the male Ferruginous Hawk. The data have been grouped under the four hunting methods described in the last section. I determined an over-all efficiency of about 15 percent. However, success rate varied according to the hunting method employed. Statistically significant differences are indicated in Table 1. The test was a chi-square with a partitioned contingency table (Cochran and Cox 1957).

Hunting from the ground was the most successful technique, probably because of the very short striking distance involved, plus the fact that the bird's attention was apparently focused on a particular prey individual which had been previously observed to be active. Hunting from a perch was the most common,

Table 1. Outcome of all attempted strikes for which hunting method was known.

Hunting from:	Total Strikes	Successful Strikes	Unknown Strikes	Success Rate†	Significance Level
Ground	81	21	1	26.2%	***
Perch	178	16	5	9.2%	**
Low Flight	120	14	10	12.7%	NS
High Flight	51	10	3	20.8%	*
Total	430	61	19	14.8%	

† Strikes of unknown success were omitted from the total.
* Significant at .10 level, but not at .05.
** Significant at .05 level.
*** Significant at .01 level.
NS Not significant.

but least successful, hunting method. The low success was probably due to the longer striking range and the necessity of scanning a relatively large area in search of prey. The technique requires relatively little energy expenditure, however, which may explain its frequent use.

Due to the great capture distance involved, strikes from high altitude are probably attempted only on the most vulnerable prey. For this reason, one might expect that the rate of success from high altitude would be greater than that at low altitude, where a strike may be an immediate response to the stimulus of a prey animal. The relative success rates for high and low flight, given in Table 1, tend to support this hypothesis, but the difference is not significant.

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Paper accepted 19 October 1974.

BOOK REVIEW:

FLIGHT IDENTIFICATION OF EUROPEAN RAPTORS
R. F. Porter, Ian Willis, Steen Christensen, and Bent Pors Nielsen. Published by T. & A. D. Poyser, 281 High Street, Berkhampsted, Hertfordshire, England HP4 1AJ. September 1974. 25.5 x 16 cm. Over 450 illustrations. 189 pp., 80 pls. £4.80.

This splendid new book will be an indispensable part of the luggage of all ornithologists visiting Europe. It is far and away the best book yet published on the subject. The fact that it cannot be crammed into one's vest pocket is amply compensated for by much larger and more detailed illustrations than found in most field guides. Furthermore, it has the considerable advantage that the drawings are complementary to the text; one is saved the tiresome job of looking for the plate, then trying to find the relevant reading matter ten pages further on.

The authors not only supply a great wealth of information on the problems of identification of the 38 different species of European raptors but also include notes on behavioral patterns and habitats. Buzzards and eagles, probably the most difficult to identify owing to individual plumage variations and the number of species involved, are dealt with in a very thorough manner.

Even the falconer will find much of interest. The Lanner and Saker Falcons (so often thought of as African species), are included. The Gyrfalcon is dealt with as one species (*Falco rusticolus*) having three color phases, rather than in the old-fashioned and often inadequate system of numerous races.

My sole criticism is but a small one: there is no mention of the pale buff terminal band on the tail of the eyass Peregrine which is a useful way of spotting an immature in bad light.

At the rear of the book there are some 80 pages of photographs of birds of prey in flight, including particularly fine shots of eagles. The layout of the material is excellent. All that is needed is a ticket to the Bosphorous to try it out. *R. B. Treleaven, Rockmount, Launceston, Cornwall, England.*

[Editor's note: This volume has gone out of print, but the publisher says a revision will be out in spring 1976.]

REPORT:

THE RAPTOR RESEARCH FOUNDATION FALL MEETING
November 23-25, 1974
University of Minnesota, St. Paul, Minnesota

by
Byron E. Harrell

The 1974 annual meeting was held at the Northstar Ballroom of the St. Paul campus Student Center of the University of Minnesota. The host committee consisted of Mark Fuller, Chairman, Gary Duke, P. B. Hofslund, Tom Nicholls, Chris Ray, Pat Redig, Paul Segmeir, and H. B. Tordoff. Groups that joined in sponsorship of the program included: Office of Special Programs, Bell Museum of Natural History, College of Veterinary Medicine, College of Biological Sciences, Department of Ecology and Behavioral Biology, Minnesota Falconers Association, Department of Entomology, Fisheries and Wildlife, University of Minnesota student chapter of the Wildlife Society. A booklet of abstracts of papers was prepared for participants. An excellent raptor art show included 85 works of over 35 North American artists. The session chairmen organized their respective sessions. Special guest speakers were Dr. Dean Amadon of the American Museum of Natural History, New York, who spoke on eagle adaptations, and Dr. J. E. Cooper, Clinical Research Centre, Middlesex, England, who spoke on anesthesia and vaccination in raptors.

In the following program an asterisk (*) indicates the author who presented the paper.

Friday, November 22

Registration and informal get-together.

Saturday, November 23

H. B. Tordoff—Welcome and Overview of Raptor Research in Minnesota.
Dean Amadon—Eagles and Some of Their Adaptations.

Bald Eagle Research Session—L. D. Frenzel, Chairman

John E. Mathisen—Some Aspects of Bald Eagle Research and Management on the Chippewa National Forest, Minnesota.

L. D. Frenzel and Joel Kussman—Evaluation of Color-marking Techniques Used on Chippewa National Forest Bald Eagle Study.

Jon E. Swenson—Some Observations on the Status of Breeding Bald Eagles in Yellowstone National Park.

James P. Mattsson—Significance of Adult Territorial Behavior and Sub-adult Bald Eagle Activity at Sucker Lake, Michigan.

Paul Nickerson and Carl Madsen—A Successful Bald Eagle Egg Transplant

Sergei Postupalsky—Adoption of Nestlings and Acceptance of Man-made Nests by Bald Eagles.
Carl G. Thelander—Bald Eagle Reproduction in California, 1972-1974.
[L. D. Frenzel—Need for Revision of Bald Eagle Nest Protection Regulations; abstract only.]

General Session—P. B. Hofslund, Chairman
Donald A. Spencer—Raptors and the Chemical-oriented Future.
William Mattox—Migration and Chlorinated Hydrocarbons of the Peregrine Falcon in Greenland.
R. Fyfe and J. J. Armbruster—Western Canadian Raptor Banding.
Clayton M. White—Preliminary Data on Peregrine Populations in Victoria, Australia.

Raptor Rehabilitation Session—Roger Thacker, Chairman
P. T. Redig—Surgical Approaches to the Long Bones of Raptors.
Tom Donald—Successful Rehabilitation of Saskatchewan Prairie Falcons Parasitized by *Ornithodoros concanescens* (presented by Lynn Oliphant).
John C. Snelling—Rehabilitation of Raptors Donated to the Oklahoma City Zoo.
Tom A. Buchanan—Raptor Rehabilitation and Zoos.

Telemetry Session—T. C. Dunstan, Chairman
R. A. Huemphner and Mark R. Fuller—Winter Ruffed Grouse-Raptor Interactions.
Sara Jane Johnson—Social Behavior of Juvenal Red-tailed Hawks.
T. H. Nicholls—Territorial Behavior of Barred Owls as Determined by Radiotelemetry.
U. Banasch and R. Fyfe—Monitoring Prairie Falcon Movements Using Telemetry.
[L. H. Rummel, M. C. Perry, and E. M. Martin—Telemetric Observations of a Male and a Female Red-shouldered Hawk; abstract only.]
Telemetry Equipment Demonstration and Discussion

Sunday, November 24
Population Dynamics Session—C. M. White, Chairman
James A. Mosher—Raptor Populations in the Wasatch Mountains, Central Utah.
M. N. Kochert—Golden Eagle-Jackrabbit Relationship in Southwest Idaho.
N. D. Woffinden—Ferruginous Hawk Nesting Habitat Vacancy during a Jackrabbit Decline.
R. Howard—Breeding Biology of the Ferruginous Hawk in Northern Utah and Southern Idaho.
C. A. Campbell—Ecology and Reproduction of Red-shouldered Hawks in Southern Ontario.
W. A. Burnham—Peregrine Falcons in West Greenland and Factors Influencing Their Dynamics.

W. G. Hunt–Speculations on Natural Regulation of Population Size in the Peregrine Falcon.
James A. Gessaman and Scott W. Sawby–Kestrel Nest Box Study.
C. J. Henny–The Osprey Nesting Population along the South Atlantic Coast.

Raptor Physiology Session–G. E. Duke, Chairman
J. A. Gessaman and S. W. Sawby–Metabolism of an Incubating Kestrel.
James A. Mosher–Review of Raptor Energetics.
J. E. Cooper–Halothane Anesthesia in Raptors.
Steven C. Pierson and Mark R. Fuller–Methoxyfluorane Anesthesia in Raptors–Preliminary Results.
D. D. Rhodes and G. E. Duke–Cineradiographic Study of Gastric Motility in Captive Great Horned Owls.
G. E. Duke, O. A. Evanson, and A. Jegers–Meal to Pellet Intervals in 14 Species of Captive Raptors.

Raptor Research Foundation Business Meeting

Raptor Management Session–R. Fyfe, Chairman
M. N. Kochert–Raptor Research in the Snake River Birds of Prey Natural Area.
E. Mattingly–Falconry as a Means of Reducing Bird-Aircraft Strike Hazards at Whiteman Air Force Base, Missouri.
R. Fyfe and H. Armbruster–Raptor Management in Western Prairie Falcons.
[T. Smylie–Hacking Captive Produced Prairie Falcons; not given.]

Ethology Session–R. W. Nelson, Chairman
R. W. Nelson and J. A. Campbell–Captive Breeding and Behavior of Arctic Peregrines (a film and commentary).

Informal Session
David Bird–Slides on Gyrfalcons on Elesmere Island.
Joseph Simonyi–Movie on Captive Breeding of Red-tailed Hawk.
R. W. Nero–Movie on Great Grey Owl.

Monday, November 25
Ethology Session–R. W. Nelson, Chairman
Joseph Murphy–Informal Report on Wedge-tailed Eagle.
R. D. Porter–Clutch Size Experiments with Captive American Kestrels.
L. W. Oliphant–Behavior of Merlins Nesting in an Urban Environment.
R. W. Nelson–Informal presentation on nesting immature Prairie Falcons.
J. A. Mosher–Golden Eagle Nest Size Selection.
R. W. Nelson–On the Diagnosis and "Cure" of Imprinting in Falcons Which Fail to Breed in Captivity.

[M. W. Collopy–Food Caching among American Kestrels Wintering in Northwestern California; abstract only.]

Pathology Session–P. T. Redig, Chairman
J. C. Cooper–The Role of Vaccination in Maintainance of Captive Raptors.
A. A. Kocan–Parasitic Diseases of Captive Raptors.

Captive Breeding Session–T. Cade, Chairman
J. Campbell–Breeding Merlins in Captivity.
David M. Bird and P. C. Lague–Successful Captive Breeding of American Rough-legged Hawks.
L. G. Swartz–Isolation of Pair Members during the Pre-breeding Period and Exclusion of Human Contact as Factors in Egg-laying in Captive Northern *anatum* Peregrines.
R. Ulbricht–Controling and Manipulating the Behavioral Aspects of Captive Breeding–Forcing Immature Large Falcons to Breed Naturally.
J. C. Snelling–Experimental Incubation of American Kestrel and Red-shouldered Hawk Eggs.
R. W. Nelson–The Two Week Factor.
D. M. Bird and P. C. Lague–A Technique for Forced Artificial Insemination in American Kestrels, *Falco sparverius* (Linnaeus).
L. Boyd–Informal slides on Artificial Insemination.
R. Ulbricht–Therapeutic Backups in Preventing Human Imprintation–Transfering Sexual Preferences from Man to Bird.
[J. H. Enderson–Captive Breeding of Peregrines; abstract only.]
Informal Reports on Captive Breeding.

Persons in attendance are listed below according to state or country.
Canada: Alberta–Ursula Banasch, Steve Bradley, John A. Campbell, Richard Fyfe, Alora Nelson, R. Wayne Nelson, Philip Trefry; Manitoba–Nikki Gerrard, Peter Gerrard, David Hatch, Jerald Jacobson, R. W. Nero; Ontario–Craig A. Campbell; Quebec–David M. Bird, Eleanora MacLean; Saskatchewan–Robert Goodhope, Lynn Oliphant.
England: John Cooper.
Peru: Tony Luscombe.
Scotland: Laurence Frank.
Alaska: David D. Cornman, Jerry Swartz.
California: Jim B. Cranmer, Fidele de la Torre, Hans J. Peeters, James Rousch, Carl Thelander, Brian Walton.
Colorado: David E. Allen, William C. Andersen, Gerald D. Craig, Babette Cranson, James H. Enderson, Paul Gertler, David E. Green, Alan Harmata, Charles Henny, Mr. & Mrs. Gordon Kearns, Patricia Kennedy, Steve Paulsen, Dale W. Stahlecker.
Connecticut: Roger Thacker.
District of Columbia: Richard R. Olendorff.

Idaho: Lester Boyd, Timothy H. Craig, Richard P. Howard, Sara Jane Johnson, Michael N. Kochert, Wayne E. Melquist.

Illinois: Thomas Dunstan, James F. Harper, Ronald L. Harshbarger, Bob Hinckley, Gary Larson, Jack Oar, Roger A. Olson, Robert Thorstenson, Krisa Thorstenson, Joseph Zawadowsky.

Indiana: B. Edwin Mattingley.

Iowa: Margaret E. Plouffe, Dean Roosa.

Louisiana: Robert S. Kennedy.

Maryland: Bob Nixon, Donald A. Spencer, Stanley N. Wiemeyer.

Massachusetts: James Baird.

Michigan: Patricia Adams, Ray Adams, Alfred Maley, James P. Mattson, Cynthia A. Payne.

Minnesota: N. Ross Adams, Cheryl Ahlstrom, Bruce Anderson, Gordon P. Anderson, Robert J. Anderson, Geri Arnold, Myles G. Bakke, Bonita Barnes, Jim Barrett, Donald Beimborn, W. J. Breckenridge, David Bruggers, Richard R. Buectt, Elizabeth Cammack, Mrs. Elizabeth Campbell, Glenn S. Christianson, Tom Davis, John Davis, Gary E. Duck, Timothy M. Dyhr, Stephen R. Fagerlie, James D. Enser, Nina S. Fraser, L. D. Frenzel, Mark Fuller, Jon Gerrard, Janet C. Green, Al Grewe, Jane Gull, Dave Halsey, Frederick Harris, Catharine Hearding, Pershing B. Hofslund, Ken Holkestad, Jeffrey Holmberg, Richard Huemphner, D. Michael Hulse, Brian Johnson, Mr. & Mrs. C. Johnson, Greg Johnson, Ronald E. Johnson, Mr. & Mrs. Greg Juenemann, Douglas C. Keran, Ronald Kneeskern, Steve Lampman, Richard E. Lee, Jr., Steve Loll, Carl Madsen, James K. Malone, Lee Manske, John Mathisen, Frank McKinney, Sean Morgan, Tom Nicholls, Lewis F. Ohman, Dave Pauly, Richard Piefer, S. C. Pierson, Pam Pietz, Dan Pletscher, Mike Pramsteller, Pat Redig, Alan R. Samuelson, Roger Schnoes, Mick Sommer, Frederick C. Strand, W. Daniel Svedarsky, Franklin J. Soobada, Franklin Taylor, Robert J. Taylor, Elaine Thrune, Stephen Thrune, H. B. Tordoff, David B. Vesall, Rick Volkmar, Bruce Waage, Ryan B. Walden, Barbara Walker, Dwain Warner, David K. Weaver, Gary Weisenberger, Jim Winter.

Missouri: Jeffrey Peters, Judith Southern.

Montana: Jon E. Swenson.

Nebraska: Dale M. Becker, Michael A. McCoy, Allen Napier.

Nevada: Steve Baptiste, Dave Jamieson.

New Hampshire: Mike Wallace.

New Mexico: Philip L. Shultz.

New Jersey: Chris Heidenreich, Ed Henckel.

New York: Dean Amadon, Tom J. Cade, Phyllis Dague, James Skiff, John V. Skiff, Jim Weaver, David Zimmerman.

North Dakota: Jim Grier.

Ohio: David Lindsey, Mike Lindsey, William G. Mattox, Mike Sayers, Mike Sheard, Harvey B. Webster.

Oklahoma: A. Alan Kocan, John Langford, Steve Platt, Jim Reidy, John C. Snelling.

Pennsylvania: Benton H. Elliott, Rodney Gehrlein, William R. Heck, Jr.
South Dakota: Paul E. Bartelt, Byron E. Harrell, Joyce Harrell, Don Hunter, Curt Orde, Karen Steenhof, Merwyn M. Terry III.
Texas: Tom A. Buchanan, Curt Griffin, Grainger Hunt, J. Shawn Ogburn.
Utah: William Burnham, Philip K. Ensley, James A. Gessaman, James S. Mosher, Joseph R. Murphy, Richard D. Porter, Stellanie Ure, Neil Woofinden.
Washington: Robert H. Young.
Wisconsin: Alan Beske, Frederick Hamerstrom, Frances Hamerstrom, James T. Harris, E. Janeice Jensen, Ursula Peterson, Sergei Postupalsky, Jonathan Reed, Robert Ulbricht, John H. Wentland.
Wyoming: Frank C. Craighead, Jr.

SPECIAL OFFER—*An extensive Bibliography on Falconry, Eagles, Hawks, Falcons and Other Diurnal Birds of Prey.* Copies numbered 201-300 of this 244-page, 7,492-entry bibliography were not distributed in order. These 3-volume sets of the limited edition of 1,000 copies are now for sale for $9.50 postpaid (original price $10.00). Less than 70 copies (all numbered in the 900's) will be left when this group is gone. Indices for these three volumes, a lengthy addendum to the first three volumes, and an update volume from 1968-1974 are now in preparation, but there are no plans to reprint the first volumes. Soon these will be available only on the secondhand book market. If interested in one or several copies of Volumes 1, 2, and 3, please send $9.50 for each set ($11.00 Air Mail) to Richard R. Olendorff, 8921 Braeburn Drive, Annandale, Virginia 22003.

Proposed Dam on Missouri Will Harm National Eagle Refuge. A plan is being developed by the U. S. Army Corps of Engineers for the increase of hydroelectric production on the Missouri. It is an effort to meet rising peak energy loads. Peak loads occur at those periods of high demand such as a hot summer afternoon when everyone's air conditioner is running or during an early evening in winter when families return home from work and school.

The hydropower program has no proposals for construction. It is a feasibility study presently considering environment, economic and social impacts. The plan, however, would involve the construction of additional generating units in each of the main stem dams except Gavins Point. It also includes the building of small dams (reregulation structures) to catch the increased flow below Fort Peck in Montana, Garrison in North Dakota and Fort Randall on the South Dakota-Nebraska border. The Corps hope to complete the study by Sept. 30, 1976.

The National Eagle Refuge. On Dec. 19, 1974, just over a 1000 acres of Missouri River bottomland near Pickstown, S.D. was turned over to the U. S. Fish and Wildlife Service to be operated as part of the National Wildlife Refuge System.

Dedication of the Karl E. Mundt National Wildlife Refuge culminated a nationwide project to secure permanently the wintering site of nearly 15% of all the American Bald Eagles located in the lower 48 states.

The National Wildlife Federation and 7-Eleven Food Stores Division of Southland Corporation joined together to raise over $200,000 to acquire title to 818

acres of land and to obtain conservation easements covering another 305 acres along the Missouri River two miles below the Fort Randall Dam.

This area has been heralded by federal wildlife authorities as one of the most vital Bald Eagle roosting grounds in the nation and is the wintering home for up to 300 Bald Eagles.

Historically, reports the National Wildlife Federation (NWF), South Dakota has long been a favorite winter nesting site for the northern Bald Eagle. Until 1956, the nation's symbol could be found every 10 miles or so along stretches of the Missouri River which remained unfrozen during the hard midwest winters.

Construction of the Fort Randall Dam in 1956 changed this pattern. When previous roosting areas behind the dam were flooded, says the NWF, the cottonwood roosts just below the dam became even more attractive to the eagles. The water, flowing regularly through the dam, keeps the river open for one to six miles downstream even in sub-zero weather.

The stretch of water is heavily populated with a wide variety of fish including shad, carp, buffalo walleye and catfish. This unique combination of food and open water plus the large stands of cottonwoods along the west bank of the river makes the area one of the most important draws for wintering eagles in the lower United States.

Wildlife officials have felt for some time that our nation's symbol needed a winter sanctuary. Even though they've been protected since 1782 [Ed.—error], the Bald Eagle's range, which once extended over most of the nation, has steadily declined. This can be traced to habitat destruction, malicious or unintentional shooting and use of persistent pesticides.

The sanctuary contains some of the last Missouri River bottom lands in all of South Dakota, remaining much as it was when Lewis and Clark explored the region in the early 19th Century.

Besides Bald Eagles, the site of the new refuge also supports a wide variety of other wildlife. The cottonwoods that provide roosting sites for the eagles also provide shelter for whitetail deer, Bobwhite Quail, cottontail rabbit, Wild Turkey, fox, coyote, oppossum, raccoon and an occasional bobcat. Muskrat, mink and beaver can be found in and around the river and its tributaries. Prairie Chickens sometimes come down off the nearby prairie hills to winter in the Missouri River flood plain lands of the refuge.

Additionally, this stretch of the Missouri below Fort Randall Dam is believed to be the last remaining spawning grounds of the giant paddlefish in South Dakota. The flowing water and gravel beds paddlefish require to reproduce were eliminated as the reservoirs were filled.

A Controversy Arises. The potential for an environmental controversy has arisen. The U. S. Army Corps of Engineers is developing a plan to establish additional hydroelectric facilities on the Missouri River main stem dams in an effort to meet rising peak energy loads.

One of the reregulation structures involved would be located just downstream from the Eagle Refuge.

The S.D. Dept. of Game, Fish & Parks (GFP) and their North Dakota and Nebraska counterparts, the National Audubon Society, the National Wildlife Federation and the S.D. Environmental Coalition, have all registered opposition to the proposal.

In a letter to the Planning Division Chief of the Corps of Engineers in Omaha, the GFP addressed itself in part to the negative impacts posed by the proposed reregulating structure below Fort Randall Dam. Some detrimental effects they foresee include: (1) material damage to an important eagle wintering area due to flooding, bank erosion and soil saturation, (2) elimination of the last stretch of Missouri River wholly within the South Dakota boundaries, (3) loss of major spawning areas for walleye and sauger, as well as the last known paddlefish spawning area in the state, (4) loss of a fishable population of game fish and elimination of boating and other recreation due to daily water level fluctuations of 10 feet and flow velocities ranging from 5 to 25 feet per second, and (5) bank erosion, loss of sand bars, willow covered islands and one wooded island.

The proposal, states the GFP, "provides little benefit to fish and wildlife or the environment." The letter says, "It seems that we again are called upon to give up more of our outdoor quality for others to enjoy a higher standard of living."

The South Dakota Environmental Coalition is more specific in its charges, according to a letter to the Omaha District Corps head, dated May 15, 1975. The Coalition alleges that "If the proposal to construct the reregulation structure were implemented, approximately 100 acres of the new refuge would be lost due to the increased flow velocity and fluctuations. The mature cottonwoods . . . would likely die as a result of increased ground water fluctuations and ultimate root saturation. The fishery resource along the 13 miles of affected river would be virtually eliminated because of the velocity of flows and the block of upstream migrations. A current study sponsored by the University of Missouri concerning food habits and daily activities of the eagles has indicated that the birds make extremely heavy use of the fish resource along the river adjacent to the refuge. With this food source eliminated, the birds would no doubt disperse, thereby eliminating the establishing objective of the refuge, as well as rendering the eagles more vulnerable to indiscriminate exploitation."

The Corps of Engineers preliminary studies indicate the project is economically feasible. A study of the principle areas of environmental concern has been initiated to determine the proper course of action, according to a recent status report.

Additional time is being allowed for "detailed economic, social and environmental impact studies, which in turn provide the basis for alternative plan and trade-off evaluation," the report says.

The Corps is seeking to complete the over-all study covering all issues and op-

portunities by Sept. 30, 1976. They hope to prepare a document suitable for Congressional action by that time. Details dealing mainly with the environmental aspects of the issue have been presented here. Those people desiring further information might contact one or more of the several agencies and organizations involved.

(From *Eco-Forum* 2(5):1-2, July 1975; originally from South Dakota Extension Service *Environmental Newsletter,* August 1975.)

Peregrine Comeback Attempted on East Coast. Dr. Stanley Temple slowly edged his way up the 75-foot iron ladder, carefully balancing a large cardboard box in one hand. Joined by Dr. Tom Cade at the top, the two biologists plucked the cargo of four screeching fluff balls from the box and deposited them in the large moving company carton. The new residents of the tower were four 12-day-old Peregrine Falcons, hatched at the highly successful captive breeding facility at Cornell University, and released as the first effort to reintroduce the Peregrine to the East Coast. Though once fairly common along the eastern seaboard, the Peregrine was exterminated east of the Rockies in the 1960's, principally due to the use of DDT. Now, through the joint efforts of the U. S. Army, the U. S. Fish and Wildlife Service, Cornell University, and others, attempts are being made to bring the world's fastest bird back to its native habitat.

The initial East Coast falcon release recently occurred on top of an old howitzer-testing tower at Aberdeen Proving Ground, an Army ordinance-testing facility in eastern Maryland. The three females and one male were released on Carroll Island, formerly an open-air test site for a variety of "military chemicals," but now considered devoid of pesticide and other chemical residues. Aberdeen ecologist Dr. F. Prescott Ward also emphasizes that the 584-acre island is ideal habitat: plenty of food, well-protected from human intrusion, and a relatively pristine area. The downy nestlings will be fed—principally minced quail and pigeon—and cared for 24 hours a day by Dr. Temple and two Army personnel until mid-summer, when they have fledged and are hunting for themselves. The birds are color-banded and are also "wired for sound," fitted with tiny transmitters to provide scientific feedback on the Peregrines' home range, migration patterns, prey species, mortality, and, hopefully, eventual reproductive success.

Later this summer, additional Peregrines will be released in upstate New York near Cornell, and in the Catskills, and in Massachusetts and several sites in the Rocky Mountain states. Additionally, a western breeding facility for Peregrine Falcons has been established under the direction of Cornell's raptor staff at a research site in Colorado in cooperation with the Colorado Division of Wildlife. Young Peregrines raised there are scheduled to be returned to western wild areas in the near future. (From *Conservation News* 40(14)6-7, 1975.)

Saving the Eagle with a Computer. Laws have been enacted, construction projects halted, habitat preserved, pesticide use restricted, hunters fined—all for the sake of the American Bald Eagle. Soon a computer will be added to the growing list of efforts to save the nation's symbol from extinction. The National Wildlife Federation's executive vice president Thomas L. Kimball has announced the establishment of a computerized eagle data bank at NWF's Washington, D.C., headquarters. "Information that may be vital to the survival of the eagle is now scattered in libraries and laboratories across the nation," says Kimball. "Pesticide effects discovered in a laboratory on the east coast may never come to the attention of a scientist studying the same bird in the Pacific northwest."

The National Wildlife Federation decided there was an "imperative need" for a one-stop clearinghouse of eagle information, after it turned 1,100 acres of South Dakota land over to the federal government for an eagle refuge last December. The new NWF data bank, utilizing both microfilm and computer information retrieval systems, will be created with the aid of an $85,000 grant from the Exxon Company, U.S.A., of Houston, Texas. It will be directed by an ornithologist who will join the NWF staff on a permanent basis. One of the first tasks of the data bank will be to pinpoint all eagle nesting and roosting sites in the "lower 48" states, with a view to acquiring and protecting some of them from further human encroachment.

Bald Eagles were once found all across the United States. There are still an estimated 6,000 of them in sparsely-settled Alaska, but in the contiguous states their number has been reduced to about 2,000 northern Bald Eagles and only about 600 southern Bald Eagles. The southern Bald Eagle has been placed on the U. S. endangered species list. Until 1940, when Congress outlawed the killing of eagles, many were shot by farmers and ranchers as predators. Since then their population has been cut down largely by destruction of habitat and by pesticides entering their food chain. By 1973 only eight states—Virginia, Maryland, Wisconsin, Florida, Michigan, Minnesota, Oregon, and Washington—had more than 25 nests. "Eagles just aren't very tolerant of man," explains Kimball. "If they are to survive, we are going to have to make some accommodations. By collecting everything that is known about how and where they live and making it available to experts in and out of government, we should be able to preserve this bird that is so much a part of the national tradition." (From *Conservation News* 40(18):10-11, 1975.)